E 1.28: SOLAR/2015-79/05

SOLAR/2015-79/05

Monthly Performance Report

KALWALL CORPORATION

MAY 1979

FEB 25 1980

U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

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MONTHLY PERFORMANCE REPORT
KALWALL CORPORATION
MAY 1979

I. SYSTEM DESCRIPTION

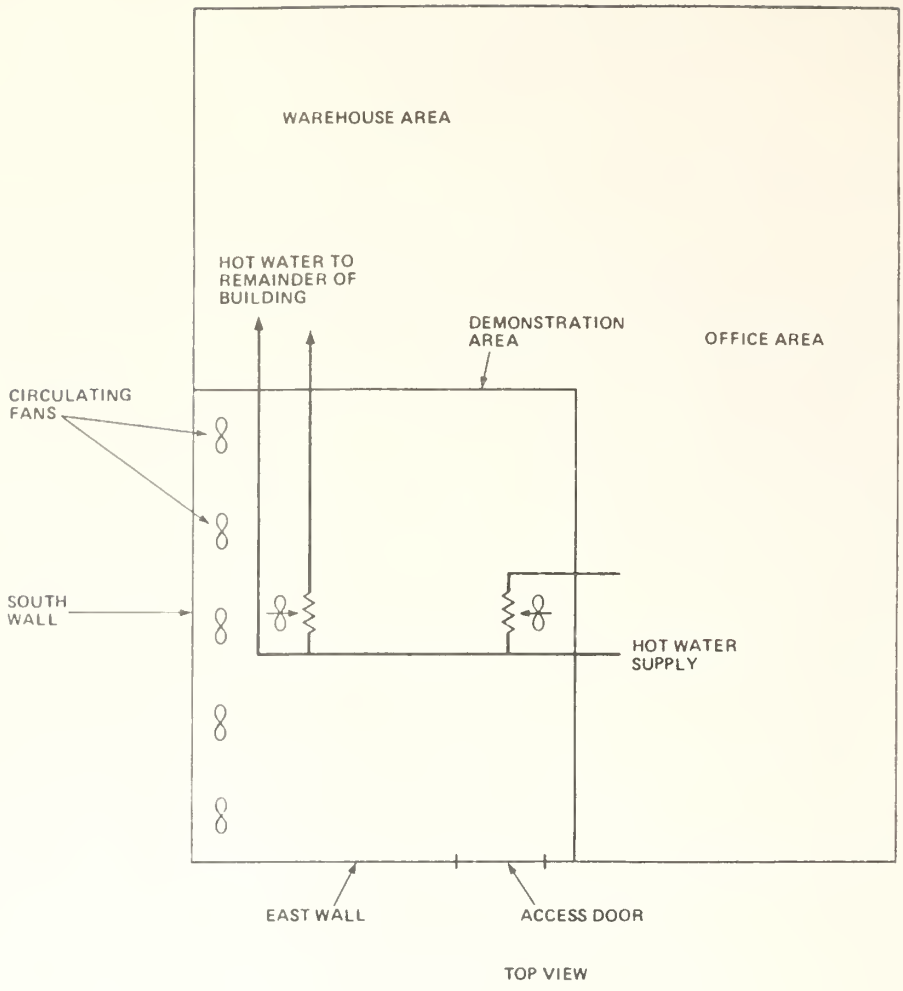
The Kalwall Corporation solar energy system is a passive space heating system of the direct gain type (Figure 1). The heated space (approximately 10,000 square feet) is a portion of a commercial warehouse in Manchester, New Hampshire. Solar energy is admitted through vertical double-glazed Kalwall panels covering the entire south and east walls. Storage is provided by the dark colored six-inch thick concrete floor of the building and the contents of the warehouse. Summer overheat protection is provided by both an overhang on the south roof edge and by natural ventilation. Auxiliary energy is provided by two liquid-to-air heat exchangers supplied by the building boiler. Control thermostats for the auxiliary system are set at approximately 60°F. Five thermostatically controlled circulating fans located along the south wall assist in distribution of the collected solar energy by operating when the temperature near the fan falls below 60°F or rises above approximately 90°F.

The system was designed to satisfy approximately 50 percent of the annual space heating demand. However, the design performance projections were made before additional insulation was added to the building roof. Consequently, revised design performance projections would be expected to predict a solar contribution of greater than 50 percent. Results of previous performance analysis for the near average winter of 1977-1978 have shown that the system does perform above these design projections.

II. PERFORMANCE EVALUATION

A. Introduction

The May report begins the summer season evaluation of the Kalwall Corporation solar energy system. During summer, or warm weather operation, the primary thermal performance concern for a passive space heating system is potential overheating of the conditioned space. In May only a limited amount of overheating was observed.



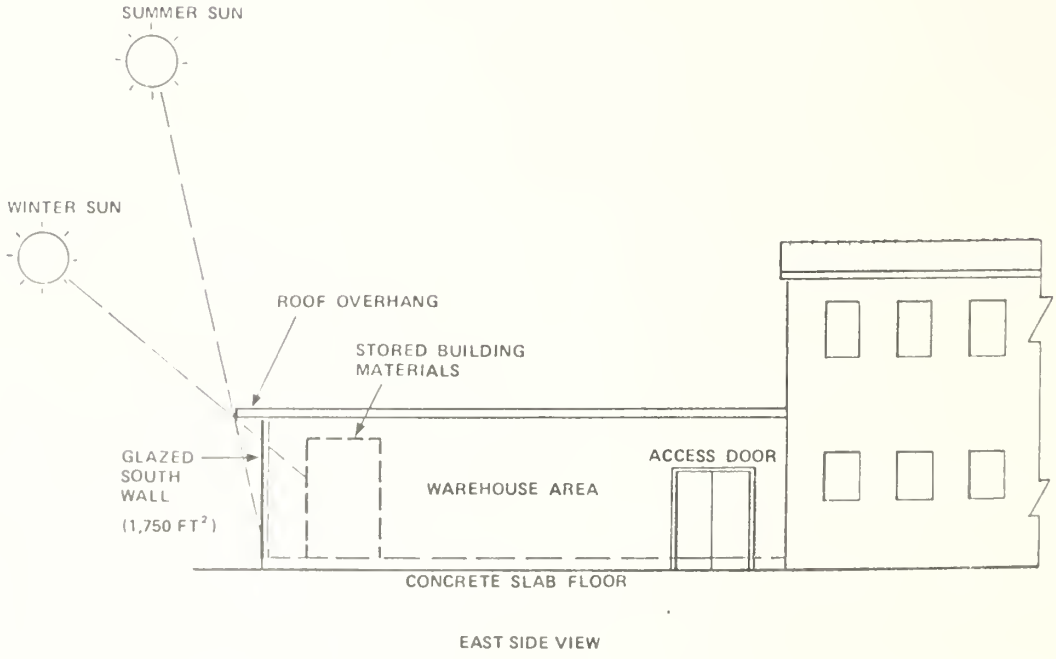


Figure 1. KALWALL CORPORATION PASSIVE SOLAR SPACE HEATING SYSTEM

B. Weather

During May, the daily average incident solar energy was 537 Btu/ft^2-day, which was less than the long-term average of 807 Btu/ft^2-day derived from measurements at the nearby Boston, Massachusetts weather station. The average outside amibent temperature of 61°F was 2 degrees higher than the long-term average reported for Boston.

C. · System Thermal Performance

Since the May performance report begins the warm weather evaluation of the system, the majority of the analysis is oriented toward discussion of a passive system's biggest potential problem -- that of overheating of the conditioned space. The monthly average temperature of the conditioned space was a comfortable 69°F. Daily variations in building temperature averaged less than 10°F with a high of 10°F observed on several days. Daily average temperatures ranged from a low of 61°F on May 26 to a high of 80°F on May 10. Since the warehouse area is not normally occupied, lower temperatures are not of great concern in the use of the building. However, higher temperatures such as those observed on May 10 pose a potentially more serious problem to some types of materials which might be stored in a warehouse.

The somewhat high building temperatures observed on May 10 were caused principally by the large amount of incident solar energy collected through the glazed east wall area. As illustrated by the temperature data presented in Figure 2, the building temperature increased dramatically during the morning hours when solar energy was incident on the east wall. The collection of solar energy through the east wall caused considerable heating of the air in the building until after noon when sunlight was no longer incident on the east wall. During afternoon hours the south wall overhang protected the south facing glazed area from the incident solar energy. Consequently, little additional increases in either building or slab floor storage temperatures were observed.

FIGURE 2. SYSTEM PERFORMANCE HISTORY - MAY 10, 1979

Approximately 29.2 million Btu of solar energy was measured on the south wall area. A significant portion of this energy was not available to the system because of shading by the south wall overhang. However, 17.8 million Btu was measured incident to the east wall. Only a very limited amount of shading protection is available on the east wall.

The overheating could have been prevented by proper venting of the building. As shown in Figure 2, the outside ambient temperature was well below the average building temperature at night. If the building had been vented to the outside air at night, cooling of the slab floor storage mass would have occurred. A cooler storage mass would have caused a reduction in the peak daytime building temperature by absorbing excess energy during the warmer daytime hours.

If some form of shading were available for the east wall, then the cause of the overheating could be eliminated. Glazed areas facing the east or west generally tend to cause warm weather overheating since the east and west walls of a building are generally more difficult to shade.

D. Observations

Since a pyranometer was added to the instrumentation to measure energy incident on the glazed east wall, several report parameters have been changed. The total incident solar energy is the sum of the energy incident on both the south and east walls, while the incident solar energy per square foot represents the energy available for the south wall only.

Several changes to the numbers in the attached computer printout are made for warm weather reporting of passive systems. The building is assumed to not have a heating load. Consequently the values of the heating load are set to zero. The performance factors relating to energy collection do not apply for the warm weather periods since the task for a passive system in warm weather is energy rejection as opposed to energy collection.

E. Energy Savings

The south wall circulating fans were used on several days in an attempt to prevent overheating. They consumed 93,000 Btu (27 kwh). This energy is applied as a penalty to energy savings.

III. ACTION STATUS

None.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: KALWALL CORPORATION
REPORT PERIOD: MAY,1979

SOLAR/2015-79/05

SITE/SYSTEM DESCRIPTION: THE KALWALL SOLAR SYSTEM IS A PASSIVE SPACE HEATING SYSTEM FOR A COMMERCIAL WAREHOUSE. THE SOUTH WALL OF THE BUILDING IS CONSTRUCTED OF TRANSPARENT SYNTHETIC PANELS WHICH ADMIT SOLAR ENERGY INTO THE BUILDING. THE CONCRETE FLOOR SERVES AS AN ABSORBER AND STORAGE MEDIUM. CIRCULATING FANS ALONG THE SOUTH WALL ARE USED FOR ENERGY DISTRIBUTION.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	47.018 MILLION BTU
	16662 BTU/SQ.FT.
COLLECTED SOLAR ENERGY	N.A. MILLION BTU
	N.A. BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	61 DEGREES F
AVERAGE BUILDING TEMPERATURE	69 DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.00
ECSS OPERATING ENERGY	0.093 MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	0.093 MILLION BTU
TOTAL ENERGY CONSUMED	0.093 MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	N.A.	0.000	N.A.	0.000 MILLION BTU
SOLAR FRACTION	N.A.	0	N.A.	0 PERCENT
SOLAR ENERGY USED	N.A.	0.000	N.A.	0.000 MILLION BTU
OPERATING ENERGY	N.A.	0.093	N.A.	0.093 MILLION BTU
AUX. THERMAL ENERGY	N.A.	0.000	N.A.	0.000 MILLION BTU
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A. MILLION BTU
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A. MILLION BTU
ELECTRICAL SAVINGS	N.A.	-0.093	N.A.	-0.093 MILLION BTU
FOSSIL SAVINGS	N.A.	0.000	N.A.	0.000 MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.000

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: KALWALL CORPORATION
REPORT PERIOD: MAY,1979

SOLAR/2015-79/05

SITE/SYSTEM DESCRIPTION:THE KALWALL SOLAR SYSTEM IS A PASSIVE SPACE HEATING SYSTEM FOR A COMMERCIAL WAREHOUSE. THE SOUTH WALL OF THE BUILDING IS CONSTRUCTED OF TRANSPARENT SYNTHETIC PANELS WHICH ADMIT SOLAR ENERGY INTO THE BUILDING. THE CONCRETE FLOOR SERVES AS AN ABSORBER AND STORAGE MEDIUM. CIRCULATING FANS ALONG THE SOUTH WALL ARE USED FOR ENERGY DISTRIBUTION.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	49.604 GIGA JOULES
	189217 KJ/SQ.M.
COLLECTED SOLAR ENERGY	N.A. GIGA JOULES
	N.A. KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	16 DEGREES C
AVERAGE BUILDING TEMPERATURE	20 DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.00
ECSS OPERATING ENERGY	0.098 GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	0.098 GIGA JOULES
TOTAL ENERGY CONSUMED	0.098 GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	N.A.	0.000	N.A.	0.000 GIGA JOULES
SOLAR FRACTION	N.A.	0	N.A.	0 PERCENT
SOLAR ENERGY USED	N.A.	0.000	N.A.	0.000 GIGA JOULES
OPERATING ENERGY	N.A.	0.098	N.A.	0.098 GIGA JOULES
AUX. THERMAL ENG	N.A.	0.000	N.A.	0.000 GIGA JOULES
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A. GIGA JOULES
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A. GIGA JOULES
ELECTRICAL SAVINGS	N.A.	-0.098	N.A.	-0.098 GIGA JOULES
FOSSIL SAVINGS	N.A.	0.000	N.A.	0.000 GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.000

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE HEATING SUBSYSTEM

SITE: KALWALL CORPORATION
REPORT PERIOD: MAY, 1979

SOLAR/2015-79/05

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR.OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	0.000	0	0.000	0.000	0.000	N	N	0.000	0.000	71	61
2	0.000	0	0.000	0.000	0.000	O	O	0.000	0.000	69	54
3	0.000	0	0.000	0.000	0.000	T	T	0.000	0.000	69	55
4	0.000	0	0.000	0.000	0.000			0.000	0.000	70	61
5	0.000	0	0.000	0.000	0.000	A	A	0.000	0.000	70	54
6	0.000	0	0.000	0.000	0.000	P	P	0.000	0.000	70	54
7	0.000	0	0.000	0.000	0.000	P	P	0.000	0.000	71	59
8	0.000	0	0.000	0.001	0.000	L	L	-0.001	0.000	72	63
9	0.000	0	0.000	0.031	0.000	I	I	-0.031	0.000	76	79
10	0.000	0	0.000	0.050	0.000	C	C	-0.050	0.000	80	82
11	0.000	0	0.000	0.011	0.000	A	A	-0.011	0.000	77	65
12	0.000	0	0.000	0.000	0.000	B	B	0.000	0.000	72	59
13	0.000	0	0.000	0.000	0.000	L	L	0.000	0.000	71	64
14	0.000	0	0.000	0.000	0.000	E	E	0.000	0.000	70	62
15	0.000	0	0.000	0.000	0.000			0.000	0.000	69	60
16	0.000	0	0.000	0.000	0.000			0.000	0.000	70	66
17	0.000	0	0.000	0.000	0.000			0.000	0.000	71	62
18	0.000	0	0.000	0.000	0.000			0.000	0.000	67	55
19	0.000	0	0.000	0.000	0.000			0.000	0.000	66	55
20	0.000	0	0.000	0.000	0.000			0.000	0.000	65	57
21	0.000	0	0.000	0.000	0.000			0.000	0.000	67	63
22	0.000	0	0.000	0.000	0.000			0.000	0.000	70	65
23	0.000	0	0.000	0.000	0.000			0.000	0.000	69	57
24	0.000	0	0.000	0.000	0.000			0.000	0.000	65	53
25	0.000	0	0.000	0.000	0.000			0.000	0.000	63	55
26	0.000	0	0.000	0.000	0.000			0.000	0.000	61	52
27	0.000	0	0.000	0.000	0.000			0.000	0.000	64	60
28	0.000	0	0.000	0.000	0.000			0.000	0.000	63	60
29	0.000	0	0.000	0.000	0.000			0.000	0.000	65	66
30	0.000	0	0.000	0.000	0.000			0.000	0.000	62	57
31	0.000	0	0.000	0.000	0.000			0.000	0.000	65	68
SUM	0.000	-	0.000	0.093	0.000	N.A.	N.A.	-0.093	0.000	-	-
AVG	0.000	0	0.000	0.003	0.000	N.A.	N.A.	-0.003	0.000	69	61
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: KALWALL CORPORATION
REPORT PERIOD: MAY,1979

SOLAR/2015-79/05

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	1031	N	61	70	N	303	6
2	1112	O	54	64	O	310	5
3	860	T	55	70	T	0	1
4	633		61	70		306	3
5	895	A	54	59	A	313	6
6	951	P	54	66	P	307	3
7	959	P	59	73	P	309	2
8	979	L	63	75	L	0	1
9	926	I	79	94	I	275	4
10	859	C	82	93	C	316	3
11	754	A	65	72	A	0	1
12	242	B	59	64	B	0	1
13	255	L	64	69	L	0	1
14	151	E	62	64	E	0	1
15	99		60	61		0	0
16	689		66	74		305	3
17	780		62	75		0	2
18	142		55	58		0	2
19	242		55	58		0	2
20	214		57	58		0	1
21	392		63	64		0	1
22	699		65	75		322	3
23	352		57	66		0	1
24	3		53	54		0	1
25	64		55	56		31	3
26	98		52	54		26	2
27	619		60	68		213	3
28	246		60	64		0	2
29	679		66	77		0	2
30	160		57	61		0	1
31	577		68	79		290	4
SUM	16662	N.A.	-	-	-	-	-
AVG	537	N.A.	61	68	N.A.	324	2
NBS ID	Q001		N113			N115	N114

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
PASSIVE SPACE HEATING

SITE: KALWALL CORPORATION
REPORT PERIOD: MAY,1979

SOLAR/2015-79/05

DAY OF MON	SPACE HEATING LOAD MILLION BTU	SOLAR ENERGY USED MILLION BTU	CHANGE IN STORE ENERGY MILLION BTU	AVERAGE STORAGE TEMP DEG F	DIRECT SOLAR UTIL EFFIC	AUX THERMAL USED MILLION BTU	BLDG TEMP DEG F	AMB TEMP DEG F	WIND AVG SPEED MPH	WIND AVG DIR DEG	SOLA FR LOAD PER CENT
1	0.000	0.000	0.116	71.7	0.000	0.000	71	61	6.0	303	0
2	0.000	0.000	-0.011	70.7	0.000	0.000	69	54	4.8	310	0
3	0.000	0.000	-0.022	70.3	0.000	0.000	69	55	1.3	0	0
4	0.000	0.000	0.033	70.3	0.000	0.000	70	61	3.4	306	0
5	0.000	0.000	-0.063	70.6	0.000	0.000	70	54	5.6	313	0
6	0.000	0.000	0.093	70.6	0.000	0.000	70	54	3.1	307	0
7	0.000	0.000	0.100	71.3	0.000	0.000	71	59	2.4	309	0
8	0.000	0.000	0.178	72.6	0.000	0.000	72	63	1.2	0	0
9	0.000	0.000	0.389	75.5	0.000	0.000	76	79	4.1	275	0
10	0.000	0.000	0.239	78.8	0.000	0.000	80	82	3.1	316	0
11	0.000	0.000	-0.328	78.2	0.000	0.000	77	65	1.3	0	0
12	0.000	0.000	-0.364	73.9	0.000	0.000	72	59	0.6	0	0
13	0.000	0.000	-0.054	72.2	0.000	0.000	71	64	0.9	0	0
14	0.000	0.000	-0.143	71.4	0.000	0.000	70	62	0.8	0	0
15	0.000	0.000	-0.104	69.9	0.000	0.000	69	60	0.2	0	0
16	0.000	0.000	0.246	71.6	0.000	0.000	70	66	2.6	305	0
17	0.000	0.000	0.054	72.8	0.000	0.000	71	62	1.6	0	0
18	0.000	0.000	-0.332	70.3	0.000	0.000	67	55	1.8	0	0
19	0.000	0.000	-0.105	68.7	0.000	0.000	66	55	1.7	0	0
20	0.000	0.000	-0.020	67.8	0.000	0.000	65	57	0.6	0	0
21	0.000	0.000	0.167	68.9	0.000	0.000	67	63	1.2	0	0
22	0.000	0.000	0.203	71.4	0.000	0.000	70	65	2.8	322	0
23	0.000	0.000	-0.161	70.9	0.000	0.000	69	57	1.0	0	0
24	0.000	0.000	-0.311	68.1	0.000	0.000	65	53	1.3	0	0
25	0.000	0.000	-0.112	66.2	0.000	0.000	63	55	2.7	31	0
26	0.000	0.000	-0.097	65.2	0.000	0.000	61	52	2.3	26	0
27	0.000	0.000	0.334	67.3	0.000	0.000	64	60	3.2	213	0
28	0.000	0.000	-0.087	67.6	0.000	0.000	63	60	1.9	0	0
29	0.000	0.000	0.388	70.1	0.000	0.000	65	66	1.7	0	0
30	0.000	0.000	-0.281	69.3	0.000	0.000	62	57	0.9	0	0
31	0.000	0.000	0.395	71.0	0.000	0.000	65	68	3.8	290	0
SUM	0.000	0.000	0.338	-	-	0.000	-	-	-	-	-
AVG	0.000	0.000	0.010	70.8	0.000	0.000	69	61	2.2	324	0
NBS	Q402	Q400	Q202			Q401	N405	N113	N114	N115	N400

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
PASSIVE SYSTEM ENVIRONMENT

SITE: KALWALL CORPORATION
REPORT PERIOD: MAY, 1979

SOLAR/2015-79/05

DAY OF MON	BUILDING COMFORT ZONE 1	BLDG COMF ZONE 2	BUILDING TEMP MIDNIGHT DEG F	BUILDING TEMP 6 AM DEG F	BUILDING TEMP NOON DEG F	BUILDING TEMP 6 PM DEG F	INTERIOR RELATIVE HUMIDITY PERCENT	AMB TEMP DEG F	DAYTIME AMB TEMP DEG F	INCIDENT SOLAR ENERGY MILLION BTU	AVG STOR TEMP DEG F
1	71	N	67	67	74	73	N	61	70	2.682	72
2	70	O	67	65	71	72	O	54	64	2.820	71
3	70	T	67	64	71	71	T	55	70	2.178	70
4	70		68	66	72	72		61	70	1.668	70
5	70	A	67	66	71	72	A	54	59	2.523	71
6	70	P	68	65	74	73	P	54	66	2.601	71
7	71	P	69	65	74	74	P	59	73	2.735	71
8	72	L	72	66	76	76	L	63	75	2.595	73
9	76	I	77	69	80	81	I	79	94	2.539	75
10	79	C	78	74	83	83	C	82	93	2.448	79
11	78	A	74	75	79	77	A	65	72	2.132	78
12	73	B	70	71	73	72	B	59	64	0.664	74
13	72	L	71	69	73	72	L	64	69	0.665	72
14	71	E	69	70	71	71	E	62	64	0.389	71
15	69		68	68	69	69		60	61	0.252	70
16	71		69	66	72	74		66	74	1.771	72
17	72		69	68	74	73		62	75	2.352	73
18	69		66	67	67	67		55	58	0.378	70
19	87		65	66	66	66		55	58	0.644	69
20	66		65	64	65	67		57	58	0.551	68
21	68		67	65	66	70		63	64	0.973	69
22	71		69	65	73	74		65	75	2.316	71
23	70		67	66	73	71		57	66	1.520	71
24	67		64	66	66	65		53	54	0.009	68
25	64		62	64	62	62		55	56	0.176	66
26	63		61	62	61	62		52	54	0.259	65
27	66		63	59	67	66		60	68	2.004	67
28	65		61	62	63	63		60	64	0.636	68
29	68		64	61	68	69		66	77	2.067	70
30	66		61	62	62	63		57	61	0.392	69
31	68		63	59	67	69		68	79	2.078	71
SUM	-	-	-	-	-	-	-	-	-	47.018	-
AVG	70	N.A.	67	66	70	71	N.A.	61	68	1.517	71
NBS								N113			

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

UNIVERSITY OF FLORIDA
3 1262 09052 6905

☆ U.S. G.P.O. 1979—640-189/4139